Effects of Spaceflight on the Human Body
Distance Learning Module

Instructional Goal

Upon successful completion of the Life Science module, the learner will be able to discuss the main effects of spaceflight on the human body and some of the countermeasures that will allow astronauts to live and work in space for long periods of time.

Performance Objectives

- Given vocabulary terms, vocabulary story, and Activity Sheet #1, the learner will be able to create 10 original sentences demonstrating knowledge of terms by mastering 8/10.
- Given a list of body systems, a list of functions, and Activity Sheet #2, the learner will be able to match the body system with it's correct function.
- Given the term microgravity, students will be able to explain how it differs from the gravitational environment we find at the Earth's surface.
- Given a list of body systems, the learner will be able to predict what happens to the body during space-flights and be able to determine possible countermeasures to help astronauts live and work in space for a long time.

Grade Level

3rd & 4th grade science.

Time Required

4 - 50 minute class periods
1 – 50 minute video teleconference

National Science Education Standards

Science as Inquiry
Science and Technology
Science in Personal and Social Perspectives
History and Nature of Science

Background Information for the Teacher

The human body is a complex system consisting of many "subsystems" that all work together to make our bodies function properly. Also, our bodies are organisms uniquely suited to Earth's environment. Among other things, this means that the human body functions best in the presence of Earth's gravity.

For the past 40 years, NASA has sent astronauts into space in the first small steps away from our home planet and toward exploring the universe. Among the many things NASA has discovered during those four decades is the fact that the human body undergoes certain changes when it leaves the familiar pull of Earth's gravity.

In space, astronauts enter an environment we call microgravity, where the pull of gravity seems very small compared to that we experience on the Earth's surface. In microgravity, people and objects appear to float. The microgravity environment also affects the behavior of many of the body's systems. As humans explore further into space, it is vitally important that we better understand the effects of spaceflight on the human body and develop solutions, or countermeasures, to safeguard astronauts from any adverse effects so that they can spend longer periods of time in space. To fully understand how spaceflight affects humans, one must begin by understanding how the body functions in the familiar environment of Earth.

As stated earlier, the body has many systems, each with a specific job to do, yet still working together so that the body functions properly. These systems include, but are not limited to, the cardiovascular system, the muscular/skeletal system, and the neurovestibular system.

The cardiovascular system is the network of blood vessels through which blood is circulated to the many regions of our bodies. At the center of the cardiovascular system is the heart, a small thick-walled muscle that pumps blood through the veins, arteries, and capillaries that complete the system. On Earth, the heart must pump against gravity to get blood to the head and brain. This is because gravity pulls, or pools, blood and other bodily fluid toward the body's lower extremities. But this all changes in the microgravity environment of space. Gravity no longer seems to pull downward as it does on Earth, and the blood and fluids in our bodies shift upward in the body cavity. The heart does not have to work as hard. After a while in microgravity, the heart becomes accustomed to this reduced workload and gets smaller. All is fine until the astronaut returns to Earth and the heart suddenly finds it must begin working harder again. After being in space, astronauts find that they must reacclimate to Earth's gravity, a change that takes a few days. Spaceflight medical researchers search for a means, or countermeasure, to help minimize the effects spaceflight has on the cardiovascular system. Such solutions are a must if we are to explore deeper into space and return later to live a healthy life here on Earth.

The muscular-skeletal system comprises the bones and muscles that form our bodies. The bones help to give us shape and structure, while the muscles enable us to make the movements we use countless times each day. The muscular-skeletal system is another system that undergoes certain changes when exposed to the microgravity environment of space.

Our bodies have frames just like buildings do. Our frame is called a skeleton, and is made up of more than 200 individual bones. In addition to giving our bodies structure, the skeleton also protects many of our vital organs. Like all other parts of our bodies, the bones that make up the skeleton are made of living cells. The bones are in a constant state of regeneration, with one type of cells tearing down the bone while another type of cells is simultaneously rebuilding the bone. Under the stress of Earth's gravity, healthy bones grow stronger during this rebuilding process. However, this is another process that changes once the human body enters the microgravity of space. In space, the bones of the skeleton are no longer stressed by gravity as they are on Earth. Spaceflight medical researchers have learned that with-

out the stress of gravity, bones do not regenerate stronger like they do on Earth. There is also evidence that bones lose calcium and become less dense during lengthy periods of spaceflight, a condition that closely resembles the effects of osteoporosis, a degenerative bone disorder suffered by many older people. Since a healthy skeletal system is so vitally important for our bodies to function properly, researchers continue to search for a countermeasure to offset or eliminate the adverse effect spaceflight has on the bones.

Although the skeleton gives us the structure for our bodies, we rely on muscles for mobility and other bodily movement. Many of us exercise our muscles with resistance, such as weights, to make them grow larger and stronger. Many of us may not realize, however, that as we move our bodies about in the presence of Earth's gravitational pull it forces our muscles to work, so we are constantly performing resistance-type exercise. In the microgravity of space, movement become less laborious since the pull of gravity seems much less to the muscles of the body. Over a period of time our muscles will weaken and deteriorate, or atrophy. After a considerable period in microgravity, the body's muscles will weaken enough that it is difficult for an astronaut to stand erect once he or she returns to Earth. In order to offset these effects of spaceflight, astronauts engage in regular exercise during their trips into space. They will spend as much as one hour each day on a treadmill or stationary bicycle. Astronauts often use elastic bands as well to work their upper body and arms.

Countering the effects of microgravity on the muscular-skeletal system is vital if we are to explore deeper into space and perhaps explore the surface of another planet. After a six-month spaceflight to Mars, we want our astronauts to be fit enough to get off the spacecraft and be productive scientists while there.

The third body system we'll examine during this learning module is the neurovestibular system. The neurovestibular system is located deep in the middle ear. It is the organ that controls our balance and our sense of direction and detects movement. If you have ever had an inner ear infection you may be familiar with the uncomfortable spatial disorientation that results. The neurovestibular system is a key organ in our bodies that supports the fact that we are creatures of gravity. Gravity is what makes the neurovestibular system work. Included in the system's workings is a collection of small hairs called otoliths. Each hair has a tiny crystal atop it. As the body moves, gravity acts upon the otoliths to tell our body if we are right side up, or moving in a certain direction. In microgravity, the neurovestibular system becomes confused because gravity no longer triggers the otoliths like it does on Earth. Suddenly our eyes and our feelings of spatial orientation do not match up. Some astronauts experience a feeling of space motion sickness that is similar to the sick feeling one may get while riding a wild amusement park ride. Space motion sickness affects each individual differently and not always the same way twice. It usually takes about 24 hours for those astronauts who experience space motion sickness to acclimate to the microgravity conditions and feel well enough to work productively. Researchers continue to study the affects of microgravity on the neurovestibular system and continue to seek effective countermeasures to combat space motion sickness. Each minute that an astronaut spends in space is extremely valuable and NASA wants its astronauts to be as productive as possible.

As your students experience this learning module they will discover how marvelous the human body is and how well suited it is for us as we live on Earth. They also will discover that the unique microgravity environment of space will offer a variety of

challenges to the human body as we continue to extend our reach out into space. *The Effects of Spaceflight on the Human Body* can be a truly remarkable learning experience for your students. Have fun!

Obtaining Needed Materials

View Glossary and Vocabulary Story and make enough copies for the students in your class(es).

VHS Video tape containing clips needed for the lesson. (Once you have registered to participate in the learning module, you will be mailed a copy of the resource video.)

Gather the following materials:

- Aluminum soft drink can
- 12 ounces of water for each group
- Wastebasket
- Pillow for each group
- Masking tape
- Blindfolds for each group
- Pencils

Schedule Video Teleconference

If a video teleconference (VTC) has not already been scheduled, do so now by calling (281) 244-7325. Video teleconferences must be scheduled at least two weeks in advance. Please allow enough time to present all five classroom components prior to the video teleconference.

Instructional Strategies

Tell students that over the next week, they are going to learn some very cool things about how our bodies work. What's really neat, is that they're going to do this by talking about space. We're going to get started by reading a story and going over a few important terms.

I. Vocabulary

- Pass out story and have students read either silently or aloud as a class.
- Review the vocabulary terms as a whole group giving examples of each.
- Have Students do Activity #1: Vocabulary Handout
- Re-teach the vocabulary if the students do not master 8/10.

II. Question, Answer, and Discussion Session

Asking questions and allowing for student discussion will arouse their curiosity of the subject. Ask questions such as:

- "Is there anyone here who knows an astronaut? If so, tell us something about what they do on their job." Answers may vary.
- "Why do you think an astronaut's job is so important to the people here on earth?" Answers may vary. Astronauts go into space to do experiments that help all of us on the earth.
- "What do you think might be different for an astronaut when they are in space?" Answers may vary.
- "What would you think if I said an astronaut's body works different in space than here on the earth?" Answers may vary.
- "First of all, how do our bodies work here on earth?" "How do we eat, breathe, move, stuff like that?" Answers may vary.

Actually our bodies are made up of many parts that have to work together. Let's look at some of them and then we can find out why an astronaut's body works differently in space.

III. Introduce the Body Systems

- Give the students an analogy of an automobile and the human body.
- A car has parts (systems) that work together for the car to work the way it's supposed to. A car has an engine, a transmission, a water pump, etc. The human body has parts (systems) too! The systems of the body work together to keep us going everyday. The human body has a digestive system, a cardiovascular system, a respiratory system, a muscular/skeletal system, a central nervous system, and many others.

- Ask the students what would happen if a part of the car was not working right? Relate this to the human body by asking, "What do you believe would happen to the human body if one of its systems was not working right?"

- Next, briefly review each of the body systems and what each does for the body.

- Explain what the neurovestibular system is. This part of the central nervous system is important for this lesson because when astronauts enter microgravity the neurovestibular system is disturbed causing dizziness, disorientation, and nausea (throwing up).

- Have students do Activity #2: Match the body system with its function.

IV. Effects of Spaceflight on the Human Body

Microgravity

- Ask students to name the force that keeps our feet on the ground.

- Ask students to name the term that causes astronauts to look like they are floating.

- Review the definition of microgravity to the students.

- Show video clip #1 that demonstrates free fall or microgravity.

- Show video clip #2 that demonstrates humans in microgravity.

- Have students do Activity #3: Microgravity

Now that we know how some of the systems work here on earth, how do you think they'd work in space? Let's start with the cardiovascular system.

The Cardiovascular System

- Before discussion of the cardiovascular system have students get with a partner and predict what they believe happens to this system of the body during a spaceflight. Allowing the students to predict what happens will motivate the students listen closely so they can find out if their predictions were right. (5-7 minutes)

- Have students do Activity #4: The Cardiovascular system.

- Now, give students the opportunity to change their predictions.

- Show video clip #2 that demonstrates the change in the cardiovascular system in space.

- Have the students work with their partner to come up with ways to keep the astronaut's cardiovascular system healthy in space and on earth after a spaceflight. Tell the students to write their ideas down so they will have them when

they speak with the NASA representative. (5-7 minutes). There are no right or wrong answers. NASA is still looking for ways to counter these effects on the cardiovascular system.

The Muscular/Skeletal System

- Before discussion of the muscular/skeletal system have students get with a partner and *predict* what they believe happens to this system of the body during a spaceflight. Allowing the students to predict what happens will motivate the students listen closely so they can find out if their predictions were right. (5-7 minutes)

- Have students do Activity #5: The muscular/skeletal system.

- Now, give students the opportunity to change their predictions.

- Show video clip #3 that demonstrates the change in the muscular/skeletal system during spaceflights.

- Have the students work with their partner to come up with ways to keep astronauts' bones and muscles healthy in space and on earth after a spaceflight. Tell the students to write their ideas down so they will have them when they speak with the NASA representative. (5-7 minutes). There are no right or wrong answers. NASA is still looking for ways to counter these effects on the muscular/skeletal system.

The Neurovestibular System

- Before discussion of the neurovestibular system have students get with a partner and *predict* what they believe happens to this system of the body during a spaceflight. Allowing the students to predict what happens will motivate the students listen closely so they can find out if their predictions were right. (5-7 minutes)

- Have students do Activity #6: The neurovestibular system.

- Now, give the students the opportunity to change their predictions.

- Show video clip #4 that demonstrates the change of the neurovestibular system during spaceflights.

- Have the students work with their partner to come up with ways to keep astronauts balanced and oriented in space and on earth after a spaceflight. Tell the students to write their ideas down so they will have them when they speak with the NASA representative. (5-7 minutes). There are no right or wrong answers. NASA is still looking for ways to counter these effects on the vestibular system.

V. Closing

Once all activities have been conducted, take time to discuss each and allow students to give their thoughts about the learning module.

Tell the students that this is a very important and serious area NASA works with all the time. It is important that you keep all your notes that you took on ways to help our astronauts so that when we meet with the NASA representative by video tele-conference, you will have your suggestions and comments ready to discuss.

Extension Activity: There are psychological (emotional) effects that occur during spaceflights. It would be an interesting extension to have the students do a web search for information concerning emotional changes astronauts experience on spaceflights. To conclude this extension, have the students present and discuss their findings.

Sample Parent Release Form
Effects of Spaceflight on the Human Body

Dear Parent or Guardian,

Our class is doing a unit to learn about the Effects of Spaceflight on the Human Body. Throughout the lesson there are experiments that will allow your child to experience some of the symptoms astronauts experience when they are in space. With your signature below you are giving your child permission to participate in the classroom experiments. If you have any questions about the activities, please feel free to call me. You can reach me at _____.

_____ _____
Parent/Guardian signature Date

Pre-Video Teleconference Requirements

Review VTC guidelines with students.

Have the class develop at least five questions associated with the *Effects of Space Flight on the Human Body* that they would like to ask during the video teleconference. Please FAX those questions to the Distance Learning Outpost at (281) 483-3789, at least 24 hours prior to your scheduled connection time. Spontaneous questions during the presentation are welcome as well.

VTC Guidelines

Although a video teleconference is viewed on a traditional video monitor or television, it is definitely *not* television. The following points should be kept in mind:

- A video teleconference is a two-way event. Not only can students see and hear the presenter, the presenter can see and hear the students.
- Students should speak into the microphone in a loud clear voice.
- When the presenter is speaking, the microphone in the classroom should be muted to prevent unwanted audio feedback.
- A teacher or other facilitator should moderate students' questions and answers to ensure an orderly exchange.
- Since video of the classroom may be widely disseminated and students are representing their school, they should be on their best behavior.
- Keep extraneous noise and talking to a minimum.
- The room should have adequate lighting to help ensure the best video quality possible.

Video Teleconference Outline

Life Sciences SME (subject matter expert) introduces him/herself

- Name
- Position/Title
- Job Responsibilities
- Education

SME asks students if they have learned anything during the lesson that they didn't know before.

SME does brief Q&A discussion with students about their newfound knowledge of the following systems, filling in any voids (SME asks the questions):

- Cardiovascular System
- Muscular/Skeletal System
- Neurovestibular System

SME will talk about Life Sciences research that is planned for the International Space Station.

SME will discuss current countermeasures NASA uses and what might be on the radar screen. He/she then queries students about any suggestions *they* might have. SME will have photos, video or other visual aids that might enhance the discussion.

Open floor for Q&A session so that students can ask questions.

End event with a motivational appeal for students to explore areas of interest, study hard, and stay in school.

Activity Sheet #1

Effects of Spaceflight on the Human Body: Vocabulary

Name_____ Date_____

Cardiovascular system	Respiratory System
Microgravity	Spaceflight
Astronaut	Nervous System
Musculoskeletal System	Gravity
Digestive System	Space Shuttle
Bone Atrophy	Muscle Atrophy
Countermeasures	Neurovestibular System

Directions: Using each term above, create 10 original sentences.
(you may use more than one word in each sentence)

1._____.

2.
._____.

3.
._____.

4.
._____.

5.
._____.

6.
._____.

7.
._____.

8.
._____.

9.
._____.

10.
._____.

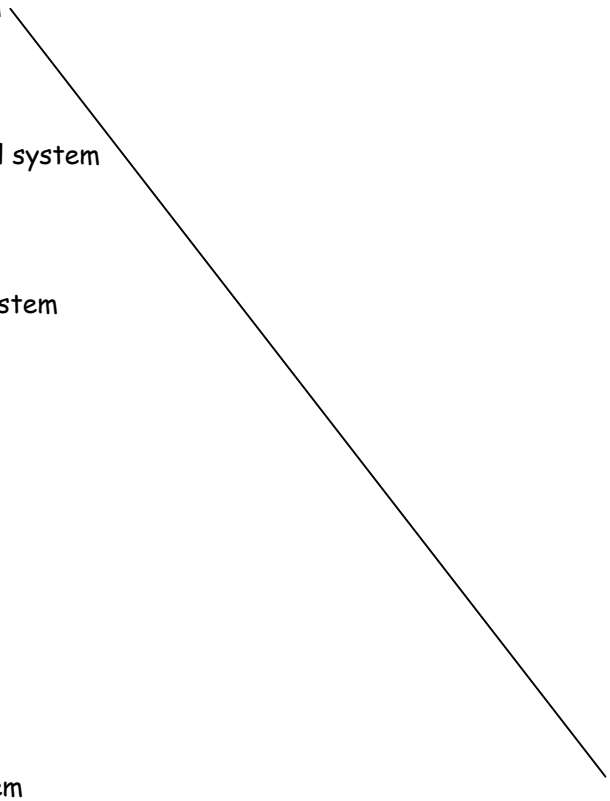
Activity Sheet #2: Human Body Systems

Name_____ Date_____

Objective: The students will match the body system with its correct function.

Time required: 15 minutes

Directions: Draw a line from the body system to its correct function. Number 1 has been done for you.



1. Vestibular system	breathing is the vital function of this system
2. Muscular/skeletal system	breaks down our food and sends nutrients to all parts of the body
3. Cardiovascular system	takes information from the body and sends out information
4. Nervous system	gives us the ability to move, dance, eat, and stand tall
5. Digestive system	circulates blood to all parts of the body, carrying nutrients and removing waste
6. Respiratory system	controls balance and body position

Activity Sheet #3: Microgravity

Name_____ Date_____

Objective: Students will demonstrate a microgravity environment and the effects of free fall in the classroom by conducting an experiment that illustrates microgravity using a soda can or styrofoam cup.

Time required: 30 minutes

Materials:

- Aluminum can or styrofoam cup
- One nail
- 12 ounces of water
- wastebasket
- activity sheet #3

Procedure:

- Place students into groups of 2 or 3 with the needed materials. Materials are listed at the front of the handout.
- Punch a small hole in the lower side of the can with the nail. Hold the can with one hand so your thumb covers the hole.
- Keep your thumb tightly over the nail hole, fill the can with water and place the wastebasket below. You may wish to stand on a chair to be higher off the ground.
- Slide your thumb off the hole so that you can see a stream of water. Then drop the can. As the can falls, the water stream stops. Why?
  Free fall creates a microgravity condition since everything is falling at the same rate. During the fall, water and the can fall at the same time, just as in the falling elevator example. The water is in a state of free fall that creates microgravity.

Have students explain how microgravity differs from the gravitational environment we find at the Earth's surface.

Activity Sheet #4a: Cardiovascular System

Name_____ Date_____

Objective: Students will understand what astronauts experience when returning to Earth from a long spaceflight by conducting an experiment that brings fluids to the head and neck area.
It is recommended that the students have parent's permission to do this activity.

Time required: 40 minutes

Materials:
- Pillow
- Activity sheets #4a and 4b
- Timer
- pencil

Teacher: Review what happens to the blood when astronauts enter microgravity.
Blood and fluids in the body move up to the chest and head area (called a "fluid shift.")

Tell the students they will experience this fluid shift by standing on their head for a period of 60 seconds. When the 60 seconds is up the students will stand up quickly to recognize the effects the fluid shift has on the body.

Procedure:
- Have students get into groups of 2 with all needed materials and Activity Sheets 4a and 4b.
- Place pillow against a wall.
- Students need to predict on activity sheet #4b what they believe will happen when they stand up after 60 seconds of standing on their head.
- Each student will stand on his or her head against a wall as partner times them for 60 seconds.
- When the 60 seconds is up the partners say, "Stand Up."
- Student stands up quickly and looks about the classroom.
- Student writes down personal observation of the experiment on activity sheet #4b. (students should feel dizzy/weak)
- Students explain in writing, on activity sheet #4b, how this activity affected them, and how they would be affected if they had to stay on their head or sideways for a real long time like astronauts on spaceflights.

Activity Sheet #5: Muscular/Skeletal System

Name_____ Date_____

Teacher: To have students simulate the changes that occur with the muscular/skeletal system would take a long period of time. To replace the hands-on experiment, give students a scenario of these changes by explaining how a child's arm or leg is affected when placed in a cast for a long period of time.

Objective: Students will explain what happens to the arm, leg, etc. when it has been in a cast for a long period of time. A hospital patient who has been confined to a bed for a long time is another good example of how bones and muscles may atrophy, or become weak.

Activity: Students who have broken an arm, leg, or knows someone who has, can explain to the class the effects of the cast on the arm, leg, or other broken bone.

Explain to the students that the effects of the cast are similar to the effects of space flight on the muscular/skeletal system.

Activity #6a: Neurovestibular System

Name_____ Date_____

Objective: Students will recognize the disorientation astronauts go through during a spaceflight by conducting an experiment with a partner.
It is recommended that the students have parent's permission to do this activity.

Materials: masking tape, timer, blindfold, pencil, activity sheets #6a and 6b.

Time required: 45 minutes

Review what happens to the neurovestibular system when astronauts enter microgravity.
When astronauts enter microgravity the neurovestibular system is fails to work the way it does on Earth and the astronauts may become dizzy and disoriented for a short time.

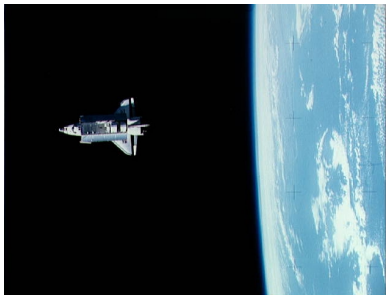
Tell the students they will experience the disorientation some astronauts go through by pairing up with a partner and doing an experiment that will disturb their neurovestibular system in their inner ear.

*Have two students go to the front of the room to demonstrate the procedure of the experiment so they will not be confused. Have one student spin a classmate around five times and then place that person at the front of the masking tape line. Begin timing the person as he/she tries to walk on the masking tape. Stop timing when they have reached the end of the tape. Student doing the timing needs to write down the time it took for the person to the reach the end of the tape. Then students change roles.

Procedure:

- Students get with a partner.
- Collect needed materials.
- Use masking tape to make 10 foot line for each pair. (students can do this)
- Decide which partner will go first.
- Spin partner 5 times to the left and then walk on 10 foot line with eyes closed.
- Record the time on Activity Sheet #6b .
- Spin partner 5 times to the left and then walk on 10 foot line with eyes open.
- Record the time on Activity Sheet #6b.
- Spin partner 5 times to the right and then walk on 10 foot line with eyes closed.
- Record the time on Activity Sheet #6b.
- Spin partner 5 times to the right and then walk on 10 foot line with eyes open.
- Record the time on Activity Sheet #6b.
- Now change places and other person do same steps.
- When both students have completed the experiment they need to complete the questions on the bottom of activity sheet #6b.

Glossary of Terms

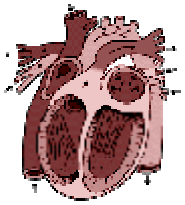
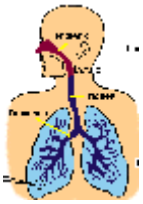
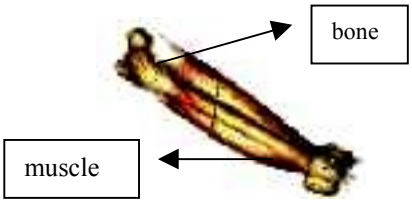
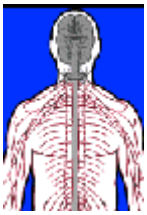
Gravity - A force nature found in the universe that attracts things to objects like a planet. Gravity is the force that keeps our feet on the Earth's surface. The apple in the picture has fallen to the ground because of the pull of gravity.	
Microgravity- An environment where the pull of gravity seems a lot less than it is on earth. The astronaut in this picture is in microgravity. It appears that the astronaut is floating.	
Space Shuttle- A reusable, United States space vehicle that carries humans into space. A space shuttle launches into space.	
Astronaut-a man or woman who goes into space. The astronaut in this picture is making a spacewalk.	
Spaceflight- Traveling through space on a space ship. In the photograph a Space Shuttle is in orbit around the Earth.	

Vocabulary Story
The Effects of Spaceflight on the Human Body

The National Aeronautics and Space Administration (NASA) Johnson Space Center has been training people to travel into space for almost 40 years. People who travel into space are called **astronauts** and the trip into space is called a **spaceflight**. Many years ago, astronauts used very small capsules to get to space. Now they get there on a space ship we call the **space shuttle**. Going into space is hard work. Astronauts must train very hard before a spaceflight. They have to practice the many things they will do while they are in space. Once astronauts get into space they do many things. They look down at the earth to learn more about it. They do lots of science experiments that can help to make things better here on earth. They also try to figure out how humans can stay in space for a long time.

Here on the earth, **gravity** pulls everything toward the ground. In space, gravity seems different. In space we have **microgravity**. Microgravity makes it seem like there is very little gravity. That's why astronauts and other things seem to float when they are in space. Microgravity can cause things in an astronaut's body to act differently than it does on the earth. You see, your body has many systems that make it work the way it is supposed to. We have a **digestive system** that lets us use the food we eat. The **muscular-skeletal system** is all of our bones and muscles. The **cardiovascular system** is our heart and blood vessels. We have a **respiratory system** that allows us to breathe. We also have a **nervous system** that allows the parts of our bodies to communicate with the brain. There are lots more systems too. When astronauts go into space, many of their systems don't work the same way they do on the ground. For example, an astronaut's cardiovascular system acts differently because more of the blood moves up higher in the body since gravity is not pulling it down the same way it does on the earth. The muscles and bones in the muscular-skeletal system are affected too. The muscles don't have to work as hard in microgravity so they can get weak, or **atrophy**. Bones can weaken too. The **neurovestibular system** is located in the inner ear. It is part of the nervous system. It is what gives us balance and let's us know up from down. The vestibular system really gets confused in space. Some astronauts get sick just like some people do on a rollercoaster. It's hard to do science experiments when you are sick,

huh? That's why astronauts look for ways to keep their body systems from changing when they go to space. When they find out how to keep a system from changing or how to fix it if it does change, they call it a **countermeasure**. Finding countermeasures will help astronauts be able to live and work in space for longer periods of time. And that will help NASA to explore space to see what's out there.

Cardiovascular system- The cardiovascular system, also called the circulatory system, includes the heart and blood vessels. The heart pumps blood through the blood vessels. The blood carries oxygen and nutrients to the cells in the body.	
Respiratory system- the respiratory system is the part of the body we use to breathe. It includes the lungs. The lungs provides oxygen to the blood.	
Muscular/skeletal system- our bones are all connected together to form a skeleton. The skeleton is the frame for our body. Muscles are attached to the skeleton so that it can move.	
Nervous system- the nervous system consists of the brain, spinal cord, and the nerves. The nervous system send signals to and from the brain and other parts of the body.	
Digestive System- The digestive system includes the stomach, the small intestines, and the large intestines. This where the food we eat is broken down into nutrients and absorbed into the bloodstream. This photograph shows the organs that are part of your digestive system.	
Neurovestibular System - an organ deep inside the ear that controls body position and balance. This photograph shows the many tiny parts of the inner ear.	

Countermeasures- products or processes(ways of doing things) that may help astronauts work and live in microgravity for long periods of time. The astronaut in the picture is exercising on a rowing machine to strengthen his muscles.	
Muscle atrophy- the wasting away or loss of muscle tissue caused by disease or by not using the muscles.	**No Photograph**
Bone atrophy- the weakening of bones that happens as we get older or when they can not develop the way they should.	**No Photograph**

Activity Sheet #6b: Vestibular System

Name_____ Date_____

Spinning Activity	Time
Spin 5 times to the left and then walk with your eyes closed	
Spin 5 times to the left and then walk with your eyes open	
Spin 5 times to the right and then walk with your eyes closed	
Spin 5 times to the right and then walk with your eyes open	

Questions:

What were 2 things you noticed when you walked with your eyes open after being spun?

1. _____
2. _____

What were 2 things you noticed when you walked with your eyes closed after being spun?

1. _____
2. _____

Now that you have experienced the disorientation some astronauts go through when they are in microgravity, what are your ideas to help train astronauts for long spaceflights?

_____
_____
_____
_____
_____
_____.

Activity Sheet #4b: Cardiovascular System

Name_____ Date_____

1. Predict what will happen when you stand up quickly after being on your head for 60 seconds.
   _____
   _____
   _____
   _____.

2. Explain how the fluid shift from the bottom of your body to your chest and head affected you when you stood up after being on your head for 60 seconds.
   _____
   _____
   _____
   _____
   _____.

3. Explain in writing how this experiment affected you. Also explain how you would feel and what you would have to do if you had to stay on your head or side for a really long time like astronauts do on spaceflights.

_____
_____
_____
_____
_____
_____
_____.